Quarterly Analytic Review Meeting

Philip Patterson

November 12, 1997

Five-Lab Study Carbon Reductions in 2010 (MMTCE)

ITEM	TOTAL	TRANSPORTATION	BUILDINGS	INDUSTRY	UTILITIES
BASECASE	1730	616	571	548	
PERCENT	100%	35.6%	33.0%	31.7%	0.0%
EFFICIENCY CASE	1610	543	546	520	
DECREASE	120	73	25	28	0
% OF DECREASE	100%	60.8%	20.8%	23.3%	0.0%
+ $25/TONNE	1500	528	527	494	-48
INCREMENTAL	110	15	19	26	48
% OF INCREMENTAL	100%	13.6%	17.3%	23.6%	43.6%
+ 50/TONNE	1340	513	509	455	-136
INCREMENTAL	160	15	18	39	88
% OF INCREMENTAL	100%	9.4%	11.3%	24.4%	55.0%
TOTAL REDUCTION					
EFFICENCY + $25/TONNE	230	86	38	41	13
PERCENT	100%	37.4%	16.5%	17.8%	5.7%
EFFICENCY + $50/TONNE	390	101	56	80	101
PERCENT	100%	25.9%	14.4%	20.5%	25.9%

Note: 1340 million metric tonnes was the U.S. total in 1990.

Comparison of OTT Estimates to the 5 and 11 Lab Studies in 2010

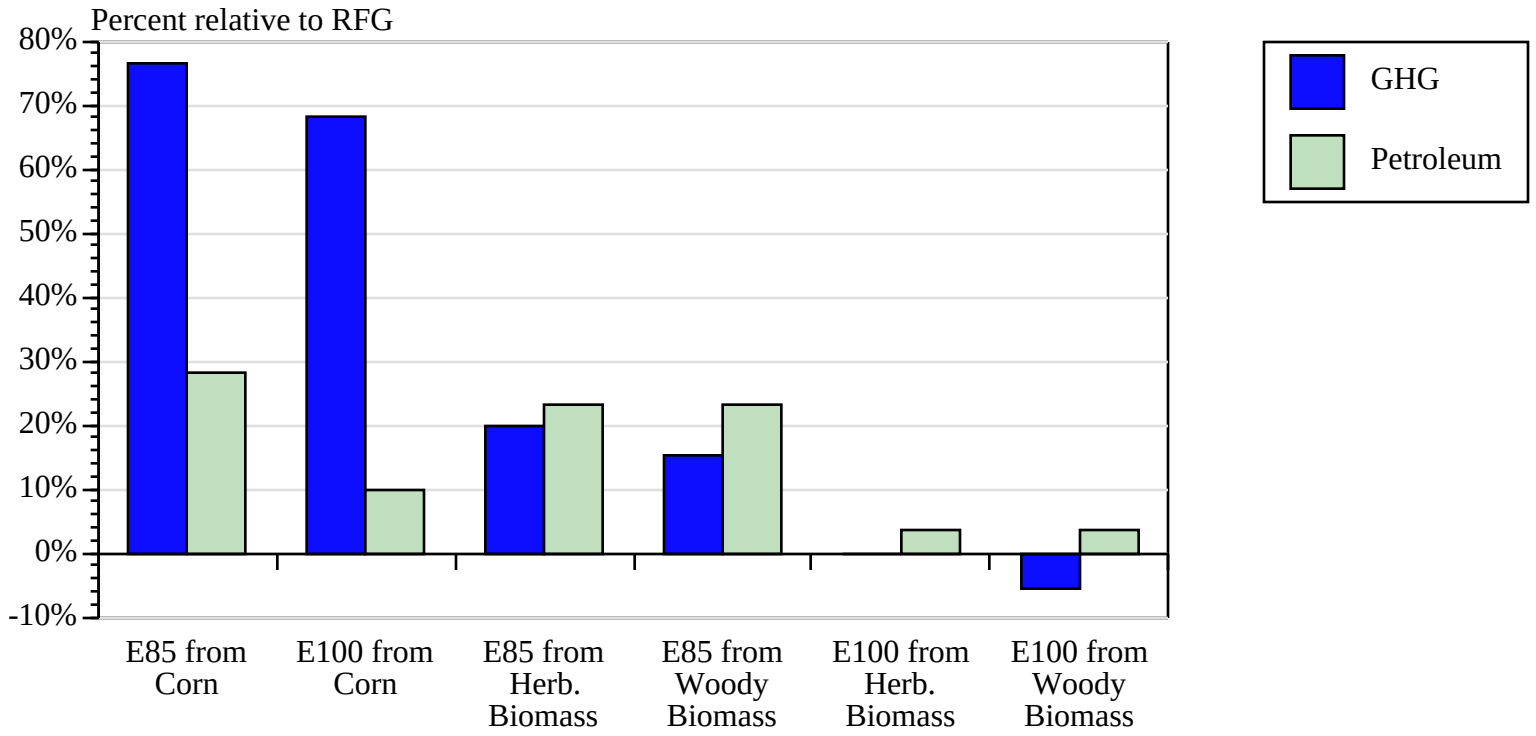
Greenhouse Gas Reductions (MTCE)

	OTT: Quality Metrics 99	5 Lab: Efficiency	5 Lab: High-Eff/ Low-Carbon	11 Lab Study
Light Vehicles	25.1	49.0	73.3	NA
Freight Trucks	1.6	11.6	14.1	NA
Air	NA	10.6	13.9	NA
Rail	NA	1.5	2.5	NA
Total	26.7	72.6	104.4	40-65

CO_2 Reductions from Corn and Cellulose Ethanol

	Corn	Cellulose
Ford Motor Company (Kinsey at CCM)	29%	60%
Michael Wang (GHG) E85 GREET 1.1 GREET 1.3	 25% 20% - 30%	 79%-92% 80%-85%
Delucchi (GHG) E95 1991 1997	 -27% 3%	 72% 88%
Bechtold (EEA) E85	-8%	90%
5 Lab Study (1997)	-20%	80%

Greenhouse Gas Emissions & Petroleum Use for Ethanol Based Fuels Relative to Reformulated Gasoline (RFG)



Source: Wang, Michael Q., GREET 1.0 - Transportation Fuel Cycles Model: Methodology and Use, 1996 (updated 11/97), ANL/ESD-33, Argonne National Laboratory, Argonne, IL.

Ratio of Gasoline to Diesel GHG Emissions from Refining of Petroleum

		Gasoline
Delucchi	2.43	NA
Wang	2.73	60 grams/mile (17% of total)

Transportation Energy Databook: Edition 17

- International: Ratio of Other Country Values to that for the U.S.
  - Gasoline Prices (1996): Canada 1.41, Germany 3.38, Japan 2.63 (p. 1-4).
  - Diesel Prices (1996): Canada 1.24, Germany 2.63, Japan 2.18 (p. 1-6).
  - MPG of Cars in Operation (1994): Germany 1.25, Japan 1.13 (p. 1-9).
  - Annual VMT per Vehicle (1994): Germany 0.63, Japan 0.52 (p. 1-11).

Transportation Energy Databook: Edition 17 (Cont'd)

- Transportation Energy Characteristics
  - Transportation Oil Use as a Percent of Domestic Oil Production = 172.7% (p. 2-4).
  - BTUs per Passenger Mile (1995) (p. 2-18)
    - Autos: 3467
    - Transit Buses: 4650
    - Air Carriers: 4236
    - AMTRAK: 2341
    - Rail Transit: 3818

Transportation Energy Databook: Edition 17 (Cont'd)

- Highway Mode
  - Average age of vehicles in use (p. 3-8).
    - Autos: 1970 (5.6 years), 1995 (8.5 years)
    - Light trucks: 1970 (7.3 years), 1995 (8.4 years)
  - Average automobile lifetime (p. 3-9)
    - 1970: 10.7 years
    - 1990: 13.7 years
  - MPG of Class 8 Trucks: 4.8 in 1977 and 5.5 in 1992 (p. 3-29)
  - No. of Federal Govt. Highway Vehicles: 584,892 in 1995 (p. 3-38)
  - 1995 CAFE Fines Collected: $40 M
  - 1995 Gas Guzzler Taxes Collected: $75 M (p.3-46)
  - Loss in fuel economy by traveling 65 mph instead of 55 mph (p. 3-50) 1973 - 12.4%, 1984 - 17.8%, 1997 - 9.9%

Transportation Energy Databook: Edition 17 (Cont'd)

- Personal Travel Statistics
  - Vehicles per licensed drivers: 0.7 in 1950, 1.1 in 1995 (p. 4-2)
  - Percent of vehicles in households (p. 4-7) in 1994:
    - One vehicle households: 18.5%
    - Two vehicle households: 39.6%
    - Three vehicle households: 24.7%
    - Other households: 17.2%
  - Percent of households with two or more vehicles (p. 4-8)
    1960: 21.3%, 1990: 54.7%
  - Percent of vehicle miles for work commuting (p. 4-9)
    1969: 33.7%, 1990: 32.1%

Transportation Energy Databook: Edition 17 (Cont'd)

⑤ Alternative Fuels
- » Production of alcohol fuels in 1996 (p. 5-14)
  MTBE = 2846 MM gallons, Ethanol = 974 MM gallons
- » Gasohol consumption (p. 5-16) in MM gallons
  1980 = .497, 1990 = 7.492, 1995 = 13.093

⑥ Non-Highway Mode

⑦ Emissions

⑧ Appendices: A--Sources; B--Conversions; C--Data Sources for International Statistics

⑨ Glossary

⑩ Title Index

Growth in Factors Affecting Transportation Impacts (1985-1995)

	Annual Percent	10 Yr. Percent
US Population	1.0%	
Licensed Drivers	1.2%	
U.S. Vehicles	2.1%	
Car VMT	2.0%	
Light Truck VMT	6.3%	
Heavy Truck VMT	3.8%	
Total VMT	3.2%	
Highway NOX		-5.8%
Transportation VOCs		-8.4%
Transportation CO		-14.2%
Carbon Dioxide		18.6%
Energy Use--Transportation	1.8%	
Energy Use--Highway	1.8%	

Light Diesel Vehicle Penetration and Fuel Price Effects

- During the July meeting, preliminary analysis of production and price effects of varying the production levels of diesel fuel v. gasoline were described.
- Discussions emphasized actual production data from U.S. and European refineries.

Light Diesel Vehicle Penetration and Fuel Price Effects

What is the expected effect on diesel fuel prices of the accelerated market penetration of diesel engine light vehicles?

- Preliminary EIA results obtained in Late August
- Results were circulated for internal OTT use only.
- Request for formal, more rigorous analysis has been prepared.

Light Diesel Vehicle Penetration and Fuel Price Effects

EIA Assumptions:

- Two cases of gasoline displacement by diesel fuel:
  - » Fifteen percent
    - 1.35 mbpd of gasoline with replaced 1.21 mpbd of diesel fuel.
  - » Thirty percent
    - 2.72 mbpd of gasoline is replaced with 2.41 mbpd of diesel fuel.
- An 11% Efficiency benefit for diesel vehicles

Light Diesel Vehicle Penetration and Fuel Price Effects

Results- 15% Case:

- Diesel fuel prices rise $0.036/gallon
- Gasoline prices drop $0.032/gallon
  - » ***Net effect is a marginal decrease in the economic attractiveness of diesel vehicles***

Results- 30% Case:

- Diesel fuel prices rise $0.065/gallon
- Gasoline prices drop $0.149/gallon
  - » ***Net effect is a strong decrease in the economic attractiveness of diesel vehicles***

Heavy Duty Market Penetration Model

- 4 market segments
- 4 payback periods
- 11 categories for annual vehicle travel
- Capable of simultaneous market evaluation of two advanced vehicles
- Placeholders for 5 advanced vehicle configurations

HDMP: Market Segments

Classes 3-6

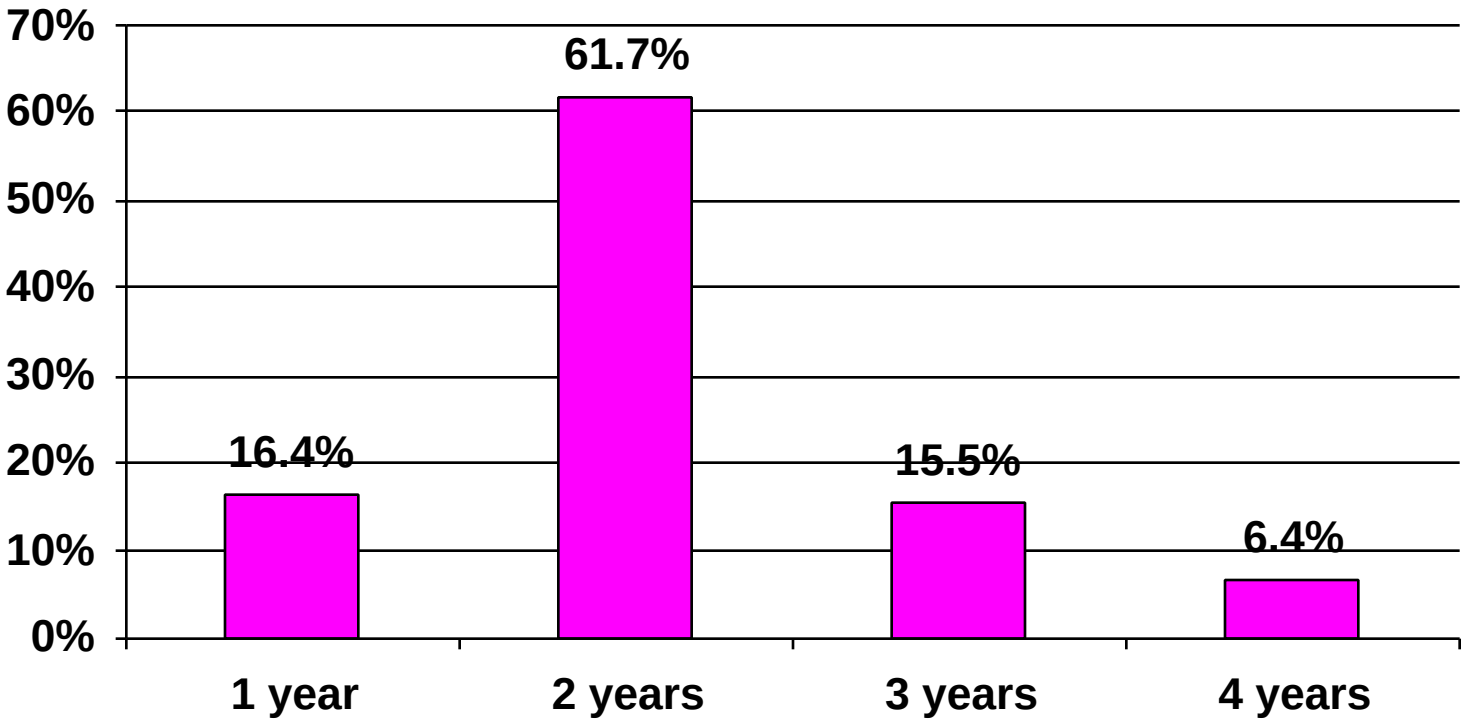
Classes 7&8

- **Type 1 (avg. mpg 4.5, 37.6k vmt/yr)**: Multi-stop or step van, beverage, utility, winch, crane, wrecker, logging, pipe, garbage, dump, and cement
- **Type 2 (avg. mpg 6.1, 64.6k vmt/yr)**: Platform, livestock, automobile transport, oilfield, grain, and tank
- **Type 3 (avg. mpg 7.7, 86.5k vmt/yr)**: Insulated van, drop frame van, open top van, and basic enclosed van

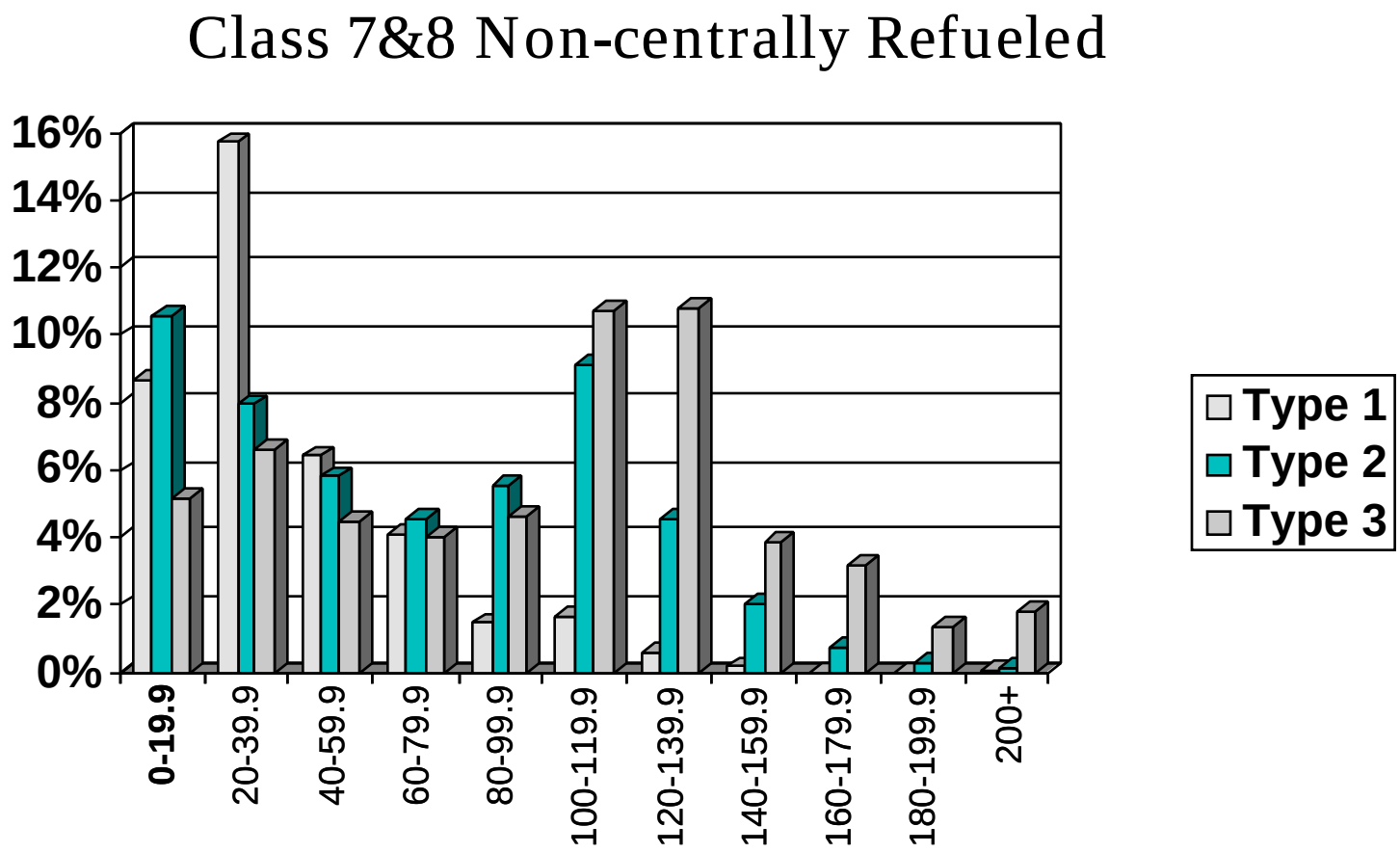
- **Segmentation by central or non-central refueling**

HDMP: Payback Periods

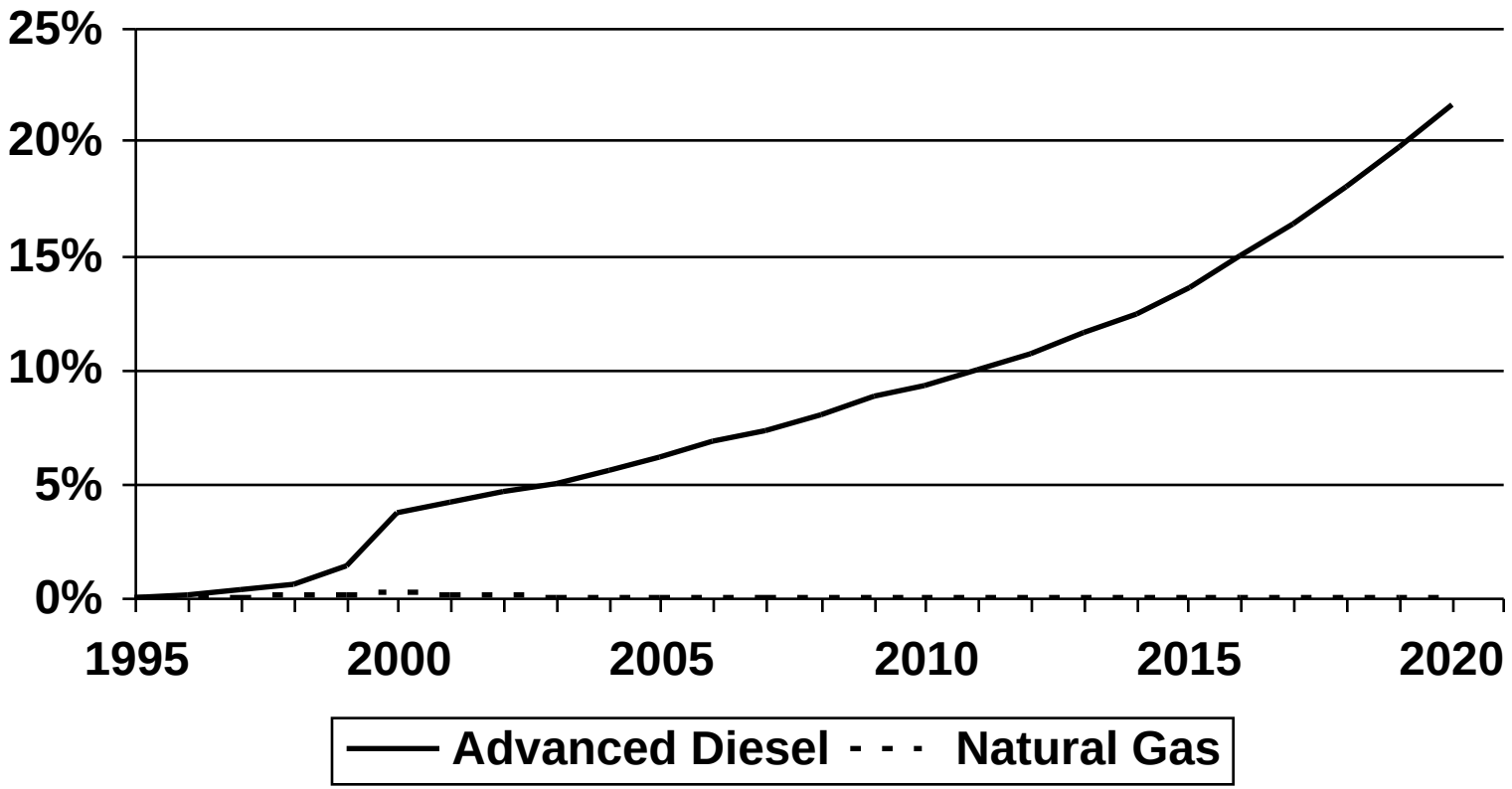
ATA 1997 survey of 224 motor carriers



HDMP: VMT Categories



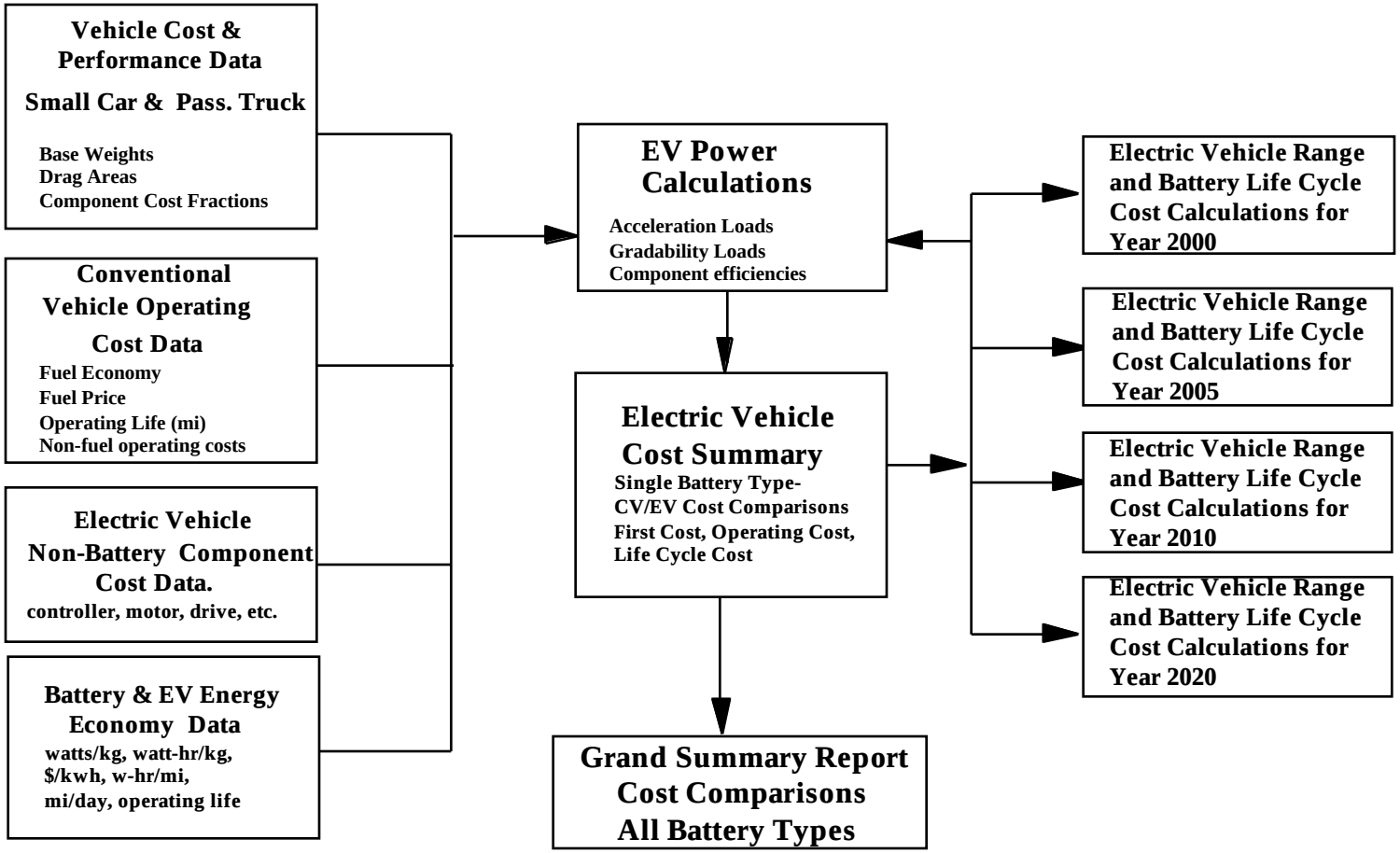
Class 7&8 Market Penetration



EV Cost / Performance Model- Background

- Being developed by ANL
- Small car and passenger truck
- Six battery types- two data sources (CARB and Delphi)
- Operating and life-cycle costs for 2000, 2005, 2010, 2020
- Include other QM planning unit technologies (future)

EV Cost / Performance Model Structure



Program Analysis Methodology: QM 99

Program Analysis Methodology

Office of Transportation Technologies

Quality Metrics
- Preliminary - 99

November, 1997

Prepared by:

OTT Analytic Team

Science
Communications
Planning

James S. Moore, Jr.
John D. Maples
Vincent D. Schaper
Philip D. Patterson

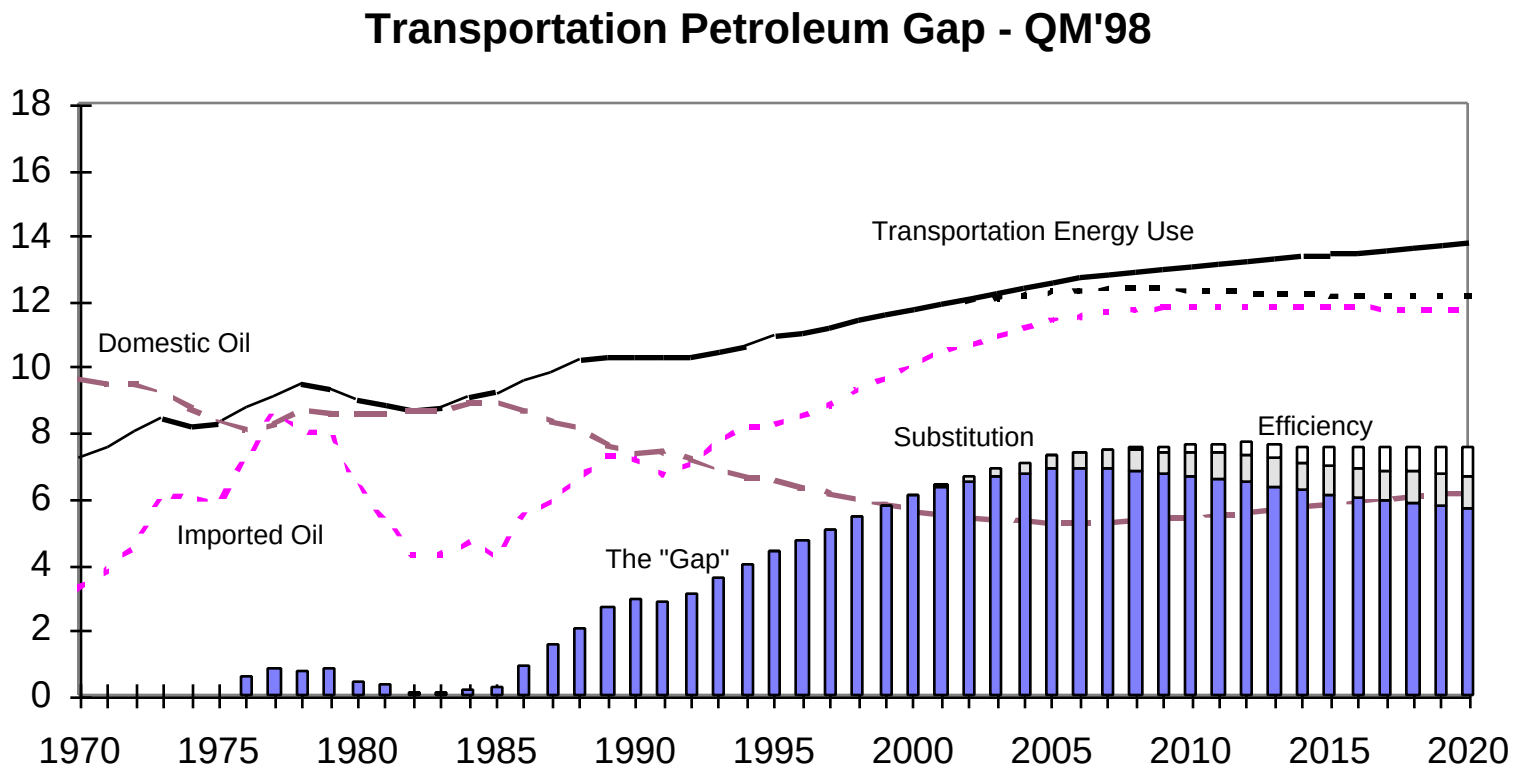
Prepared for:

U.S. Department of Energy
Office of Transportation Technologies
Washington, D.C.

Turning The Corner

	QM'98/ AEO'96	QM'99/ AEO'97	QM'98/ AEO'98
Turn Corner on Trans. Oil Use	2005	2014	NO
Reverses	NO	2016	N/A
Turn Corner on Oil Imports	2013	NO	NO
2015 Trans. Oil Demand (MBPD)	13.4	15.3	16.5
Trans. Oil Savings (MBPD)	2.1	2.0	2.0

QM'98 / AEO'96


Transportation Petroleum Gap - QM'98
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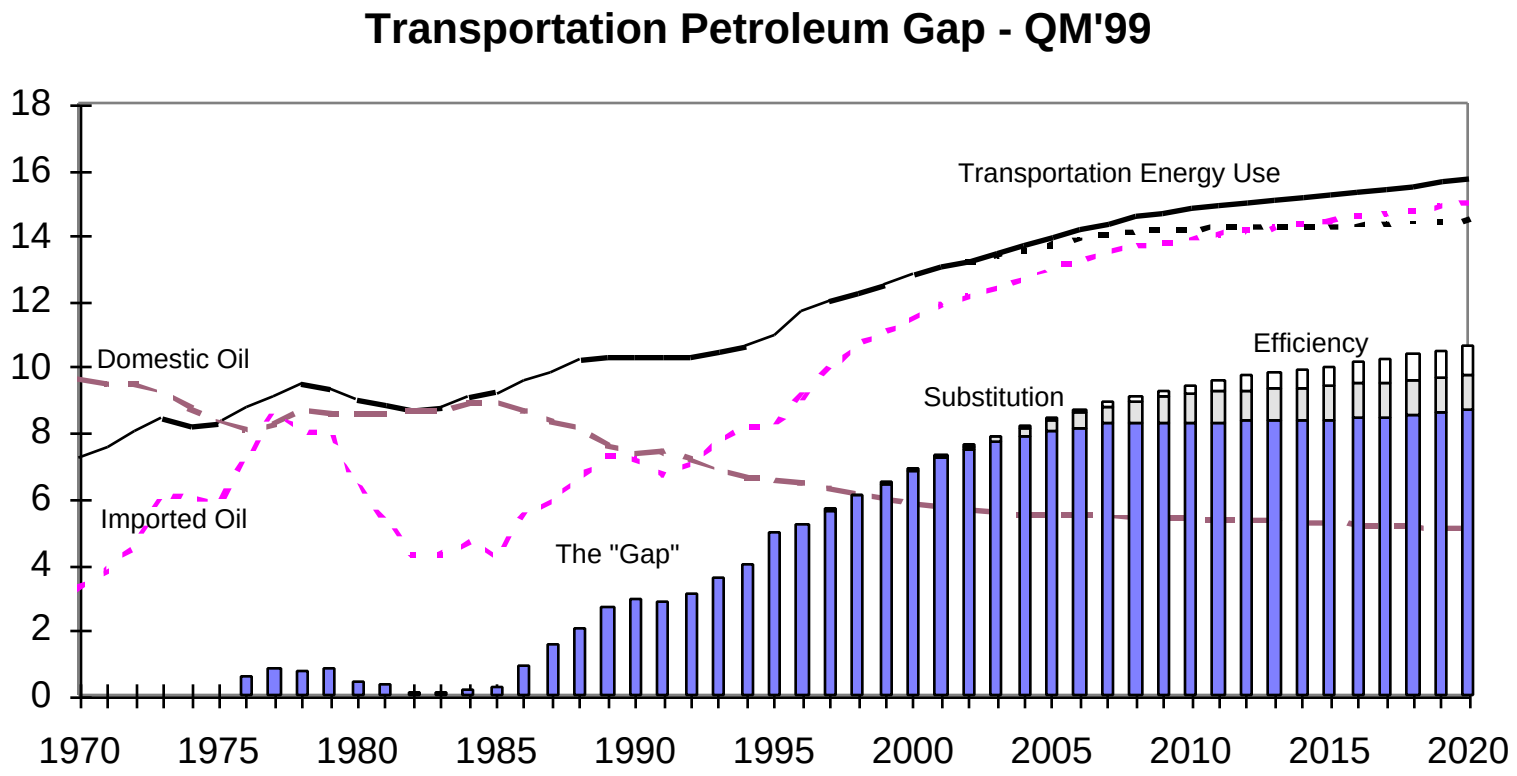
Transportation Energy Use
Domestic Oil
Substitution
Efficiency
Imported Oil
The "Gap"

QM'99 / AEO'97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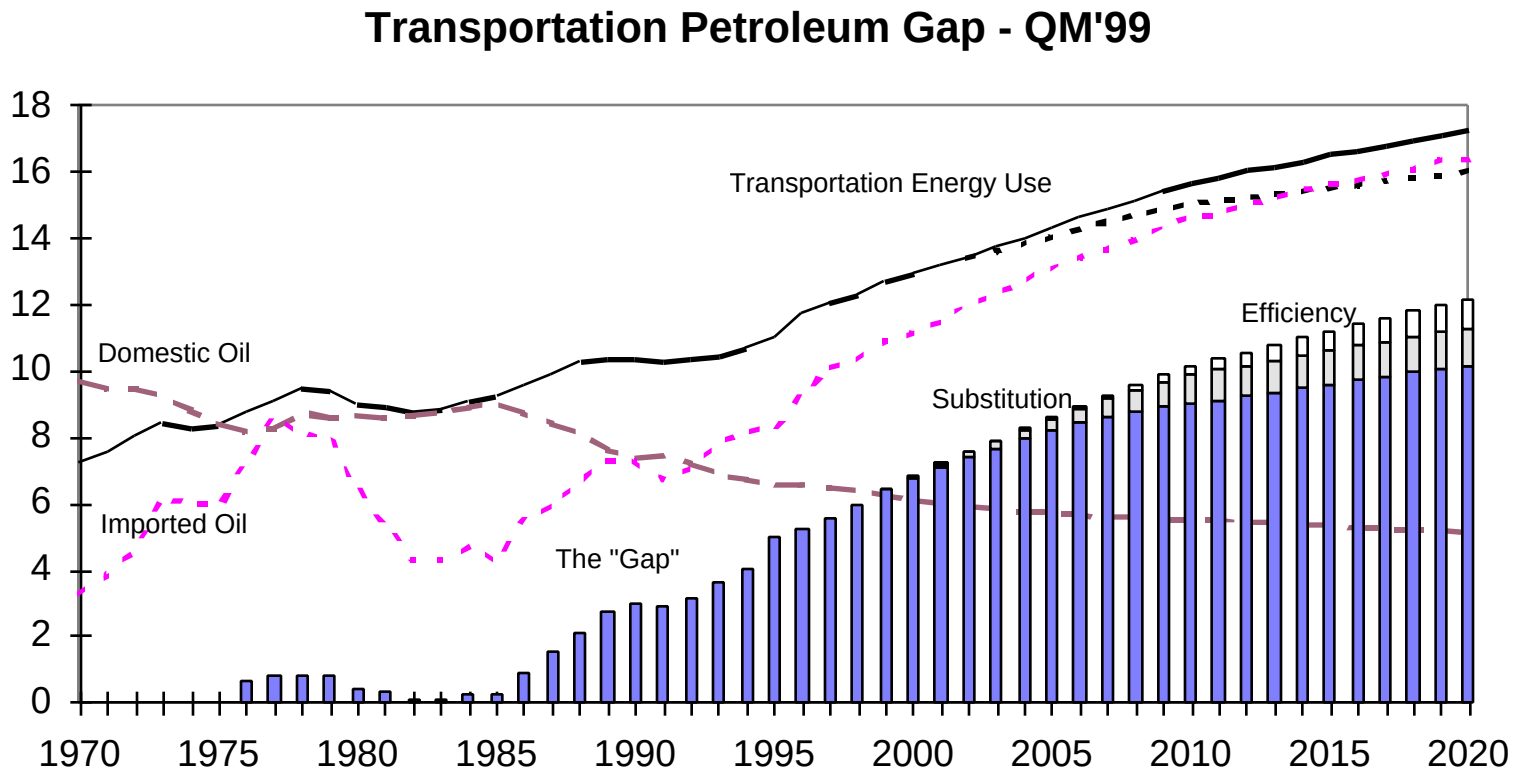
QM'99 / AEO'98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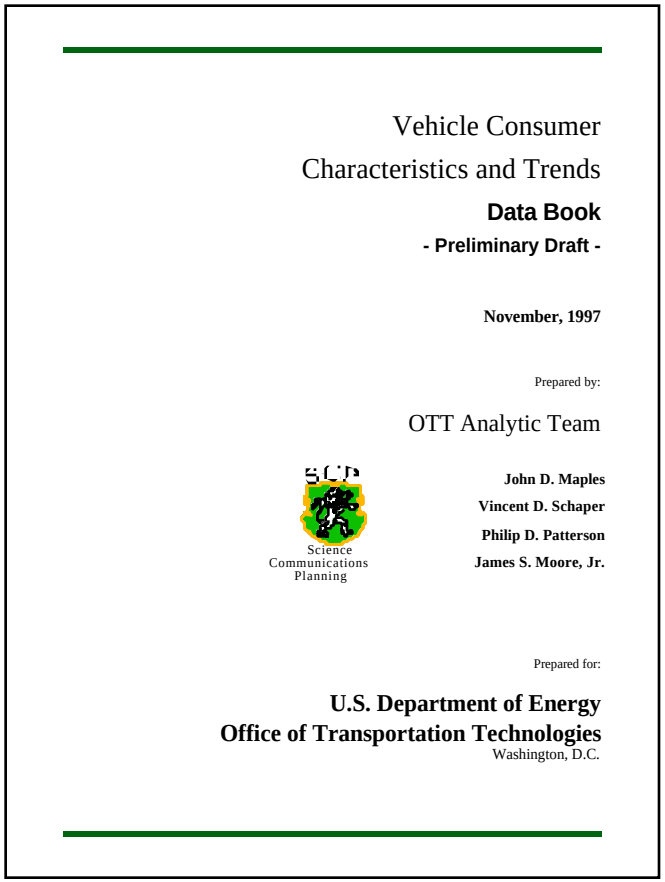
Benefit-Cost Comparison ($ MM)

	2000	2005	2010	2015	2020
Costs					
Budget Costs	$600	$1,600	$2,000	$2,000	$2,000
Total	$600	$1,600	$2,000	$2,000	$2,000
Benefits					
Energy Savings	$400	$8,023	$37,704	$100,026	$189,485
Oil Security ($4 + $33 per bbl)	$1,087	$19,712	$75,851	$167,014	$285,641
Gasoline Price Decline	$2,520	$6,925	$11,503	$16,138	$20,778
Distillate Price Decline	$511	$1,419	$2,379	$3,376	$4,386
Residual Price Decline	$265	$755	$1,297	$1,885	$2,517
Natural Gas Price Rise	($1,765)	($4,857)	($8,064)	($11,368)	($14,760)
CO2 ($55 per tonne C)	$57	$879	$5,620	$15,464	$29,212
NOX ($3,300 per ton)	$11	$352	$1,710	$3,932	$5,574
CO ($360 per ton)	$18	$601	$3,903	$13,283	$28,065
HC ($3,660 per ton)	$18	$487	$2,636	$7,967	$15,298
Incremental Costs	($4,416)	($39,269)	($78,183)	($126,755)	($186,805)
GDP Benefits	$2,180	$23,141	$65,819	$127,420	$206,081
Total	$884	$18,167	$122,176	$318,383	$585,472
Benefit-Cost Ratio	1.47	11.35	61.09	159.19	292.74

Consumer Study



Vehicle Consumer
Characteristics and Trends

Data Book

- Preliminary Draft -

November, 1997

Prepared by:

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Surveys on Climate Change

- Sustainable Energy Budget Coalition (December 1995)
- "In your mind, how serious a threat do you think global climate change , also known as global warming, caused by emissions from the combustion of oil, gasoline, and coal is?"
  - Very serious: 35.5%
  - Somewhat serious: 35.4%
  - Not too serious: 16.0%
  - Not a threat at all: 8.7%
  - Don't know: 4.4%

- World Wildlife Fund (August 15, 1997)
- "Generally speaking, how serious of a threat do you think global warming is today, very serious, somewhat serious, not too serious, or not serious at all--or don't you have an opinion on this?"
  - Very serious: 24%
  - Somewhat serious: 42%
  - Not too serious: 12%
  - Not serious at all: 7%
  - Don't know: 14%

Surveys on Oil Imports

- Opinion Research Corporation International (November 9, 1997)
- "What percentage of oil used in the US is imported?"
  - 0% to 19%: 3.0%
  - 20% to 39%: 8.7%
  - 40% to 59%: 20.7%
  - 60% to 79%: 45.1%
  - 80% to 100%: 22.4%
- "The actual import percentage is 50% and is projected to grow. How concerned are you over the amount of oil the U.S. imports?"
  - Very concerned: 35%
  - Somewhat concerned: 41%
  - Not too concerned: 14%
  - Not concerned at all: 9%
  - Don't know: 0%

Survey on Oil Imports: Reasons for concern or lack of it

- Why concerned
  - Makes U.S. dependent on foreign countries; U.S. should use its own energy resources
  - Gives foreign countries too much influence; could cause international conflicts; M.E. is volatile; possibility of cut-off
  - Takes jobs from U.S.; bad for economy
  - Trade imbalance
  - Environmental concerns
  - Oil supply is finite
- Why not concerned
  - Importing oil conserves U.S. resources
  - Importing oil keeps prices down
  - Economy is global
  - Importing oil is necessary/U.S. can't meet its own needs
  - U.S. has its own oil resources

EIA Coordination

- AEO'98 High Technology Case
  - » EIA used OTT vehicle attributes
  - » Switched to positive value Constant terms
- Diesel Fuel Price Sensitivity Analysis
- Heavy Duty Market Penetration
- Vehicle Choice Modeling

Vehicle Choice Modeling

- Starting with 11 Light Duty Vehicle Size Classes
- 10 Vehicle/fuel coefficients to be tested
  - » vehicle price, fuel cost, maximum range, maintenance cost, EV battery cost, acceleration, fuel availability, number of veh. in use, home refueling, range
- Coefficient development to be completed by January 1998

OTT Success Stories: Background

- Information provided in response to request to quantify the benefits from successful technologies.
- Analyses conducted for 9 technologies

OTT Success Stories: Benefits

TECHNOLOGY	Oil Savings - 2010	
	BTU x 10^{12}	Million Barrels of Oil
Fuel Efficient Tires	80.0	13.7
Advanced Induction Hardening	2.3	0.4
Fuel Cell Multi-fuel Reformer	8.1	1.4
Advanced Natural Gas Vehicle	1,375.0	237.3
Lightweight Material Manufacturing	0.087	0.015
Ultrasafe, Ultra-low Emissioon School Bus	36.0	6.2
Used Cooking Oil to Clean Bio-diesel	20.8	3.6
New Auto Air Bag Design	4.1	0.7
Tail-pipe Diesel NOx Control	Emissions only	

Proposed Tax Incentive to Commercialize PNGV

- Extend current EV purchaser tax credit to 2010 and clarify that the credit covers PNGVs.
- Provide two levels of credit:
  - 10% (up to $4,000) for cars with fuel economy greater than 80 mpg and light trucks with fuel economy greater than 60 mpg, and
  - 5% (up to $2,000) for cars with fuel economy greater than 65 mpg and light trucks with fuel economy greater than 40 mpg.
- The credit is phased out between 2007 and 2010.

Asilomar 1997: Findings

- 2, 20, and 80 page summaries are available.
- Regulations were successful (criteria pollutants, CAFE).
- Fuel prices have little effect on vehicle use.
- Land use policy has little potential for reducing transportation energy use.
- Greenhouse gas emissions are not a consumer concern today.

Asilomar 1997: Conclusions

- Tradeoffs will probably have to be made
  - » NO_X v. CO_2
  - » PM v. Criteria Pollutants
  - » PM v. CO_2 (mandatory use of NG buses)
- Regulations
  - » Must be flexible
  - » Force nearly equal hurt to manufacturers
  - » Consumers are willing to sacrifice if everyone does it
- Technology is still the answer
  - » EV technology can be used for other applications
  - » Low sulfur fuels are possible

Some of My Asilomar Highlights

- Toyota HEV
  - » Toyota described it
  - » GM said it could not pass emissions and had poor driveability
  - » John German (EPA) said GM was wrong on both counts
- Land Use Programs
  - » A trendy issue that is not effective in reducing VMT, emissions, or energy
  - » “Sprawl” is really “decentralization”
- Mark Delucchi: We need an energy [oil] breakthrough book (like Carson’s Silent Spring)
- Toyota found in survey that 8% of buyers are “eco-friendly”
- GM: Big 3 initially thought PNGV probability of success was zero. Now they think there is some chance.

DOE Strategic Plan: The DOE Mission

To foster a secure and reliable energy system that is environmentally and economically sustainable, to be a responsible steward of the Nation's nuclear weapons, to clean up our own facilities, and to support continued United States leadership in science and technology.

DOE Strategic Plan: The DOE Vision

The DOE, through its leadership in science and technology, will continue to advance U.S. energy, environmental, economic, and national security by being:

- A key contributor to ensure that the United States has a flexible, clean, efficient, and equitable system of energy supply and end-use with minimal vulnerability to disruption;
- A vital contributor to reduce the global danger through its national security, nuclear safety, and nonproliferation activities;
- A world leader in environmental restoration, nuclear materials stabilization, waste management, facilities decommissioning, and pollution prevention;
- A major partner in world class science and technology through its National Laboratories, research centers, university research, and its educational and informational dissemination program; and
- A safe and rewarding workplace that is recognized for business excellence, nurtures creativity, is trusted, and delivers results.

DOE Strategic Plan: Strategies

① ENERGY RESOURCES: The DOE and its partners promote secure, competitive, and environmentally responsible energy systems that serve the needs of the public.

- » Reduce the vulnerability of the U.S. economy to disruptions in energy supplies.
- » Ensure that a competitive electricity generation industry is in place that can deliver adequate and affordable supplies with reduced environmental impact.
- » Increase the efficiency and productivity of energy use, while limiting environmental impacts.
- » Support U.S. energy, environmental, and economic interests in global markets.
- » Carry out information collection, analysis, and research that will facilitate development of informed positions on long-term energy supply and use of alternatives.

② NATIONAL SECURITY

③ ENVIRONMENTAL QUALITY

④ SCIENCE AND TECHNOLOGY

⑤ CORPORATE MANAGEMENT